A New Training Equipment and Method for Increasing Speed and Strength

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抄　　録

この特殊なトレーニング方法および装置は，競技スポーツの動きのなかで筋力やスピードの強化を可能にするため，工夫されたものである。走・跳の実際の動きのなかで実施可能ないわゆるSpecial training方法として考案されたものである。

さらに現在はNASAのある研究班に取り上げられ，無重力状態で常時着用することが出来，携帯便利と軽量の利点をもつもので，将来宇宙ステーションのトレーニング方法になるのではないかと，その効果について検討されているものである。一方，リハビリテーションのスポーツ療法としての実用性と価値は，マレーシアのUniversity Sainsの医学部生理学教室で，長期臥床の患者に取りつけ，下肢の抗重力筋の萎縮や骨の脱灰(Osteoporosis)の予防として，臨床テストに使われているものである。

本実験は100m走と12分間走，即ち，短距離走と長距離走の走運動中に，このトレーニング装置を着用するものと，着用しないものとの間のPerformancesの相違および心拍数の変化についてみたものである。結果は下記のように要約される。

1．100m走の場合，Driving Legの膝のPick-upが速くなり，そのためStep Frequencyが増加し，その反面Driving LegがExpansable Tubeからの抵抗により，Step Lengthが短くなった。上記の二つの走速度を決定する要因の変化にもかかわらず，100m走の所要時間にはほとんど差が見られず，僅か0.3秒の差はあるが統計的有意ではなかった。

2．12分間走の走距離と心拍数の関係については，着用したものと着用しないものとの間に顕著な差が見られた。着用した場合走距離が約400m取る減少（2992.56：2608.33m）し，その減少率は13%である。心拍数では着用したグループが有意に増加（161.25：153.67回／分）し，その増加率は約5%である。

3．Expansable Tubeの牽引力(抵抗力)は，Easy Speed Runningの時の最大伸展時に約5kgの張力がかかり，Top Speedでの走運動時ではLoad Cellの立ち上がりとExpansable Tubeの収縮と伸展との間に時間のずれが大きく，正確に測定することができず。遠隔操作が可能で携帯便利な新しい機械の出現に期待する。

INTRODUCTION

A Key point to sucess in competetion sports, modern athletic training emphasizes largely upon how to increase muscle strength.[1,2,3,4] Weigth training then thought to be very useful, but at the same time a lot of athletes refrained from doing it for fear of injury, or increase muscle mass too much that may lose the joints' flexibility and harm for the actual movement pattern which might be need by the sports.[9]

With this in mind, it is important to device a new training system and equipment that can be used easier in any situation during training. Furthermore, we found very common that the weight training truly did increase maximum muscle strength, but not the performance that we expected it might come proportionally to the increase of mucsle

strength. For this purpose a special training system with its equipments were designed which could be used in actual movement patterns of most of the sports, and no fear for injury as compared with the conventional way of weight training.

METHOD

Twelve healthy male university handball players were subjects for this study (Table-1). Subjects were asked to dash 100m and run 12 minute. The 100m running time, step length, and step frequency were measured. Distance of 12 minute run and heart rate after 12 minute run were measured too. Functional differences of muscle contraction between put on the expansable tube and without putting on it during walking and running were compared by using the surface electrode to record the EMGs from muscles of lower extrimity. Muscles were M. gluteus medius, M. rectus femoris, M. biceps femoris, M. tibialis anterior, M. gastrocnemius, M. soleus, and M. peroneus longus. Tension of the expansable tube also checked with the load cells while walking, jogging or running at different speed. Illustrative figure of the expansable tube training equipment and its outline is shown in the figure 1. Three length adjustable bands were needed for fixing the tube on the shoulder (1), waist (2), and feet (3) from the shoes, (4) is the expansable training tube. The tension of expansable tube is alternatively by adjust its length or add the number of tube. fasten the tube to shoe are dislocatable wherever one wish to put it on or take it off.

Result (Finding)

100m dash : The running time for 100m is shown in Table-2 and Fig-2, there is no significant change in running time, while using tube the peak tension at the time before the end of driving increased to about 4kg for a tube in each leg but the time remained no prominent change statistically. In this study 100m dash was performed accelerative running, standing start was employed 10m before 100m start line. The subjects were put on warming-up shoes instead of spick shoes.

Step length were shortened, though not significant, while step frequency increased in 100m dash (Table-2 and Fig.-3, 4). The shortened of step lenght due to the increase of resistance from the tube at the time while leg thrust during driving. This disadvantage then soon be recoveried by the fastened of knee pick-up, becouse the tension storied in tube made a great deat of advantage to bring the knee to move fast soon after the driving leg break contact with ground. In speed training over load is necessary for the purpose of strengthening power of thrusting, and should conduct under the condition that move fast to build up high power for sprinting.[2,3,6,11] The tube provided all the possiblities to meet the demand of speed training.

12 minute run and heart rate : Distance of 12 minute run were reduced significantly while using tuble (Table-3 and fig.-5, 6). The resistance that against the thrusting of driving leg from the tension of the tube made the runner to run under the disadventage of shorter step length, and long running distance may stress runner harder as compared with sprint run. The heart rate didin't reduced even through the mileage of running was decreased by the use of tube. It means that the stress upon cardiac-respiratory and cardiac-vacular circulatory system remained no change, or even increased. From this factor that we believe for a busy person to pursue his daily exercise, this training system help him to reach the goal of desired training

TABLE 1 PHYSICAL CHARACTERISTIC OF SUBJECTS

ITEMS / SUBJECT	AGE (YEAR)	HEIGHT (CM)	WEIGHT (KG)
TAKAMORI	18	173.3	74.5
KOJIMA	18	167.9	66.0
TANAKA	18	175.3	69.0
OKUI	18	171.7	62.9
NISHIKAWA	18	165.5	60.0
MATSUURA	18	167.4	66.2
FUKASE	18	173.1	72.2
HASEGAWA	18	178.8	74.2
MOTEGI	19	171.1	65.4
NAKAGAWA	19	168.4	66.4
OHSHITA	21	172.5	72.5
TERAO	19	171.3	69.5
MEAN	18.5	171.36	68.23
SD	0.867	3.534	4.356

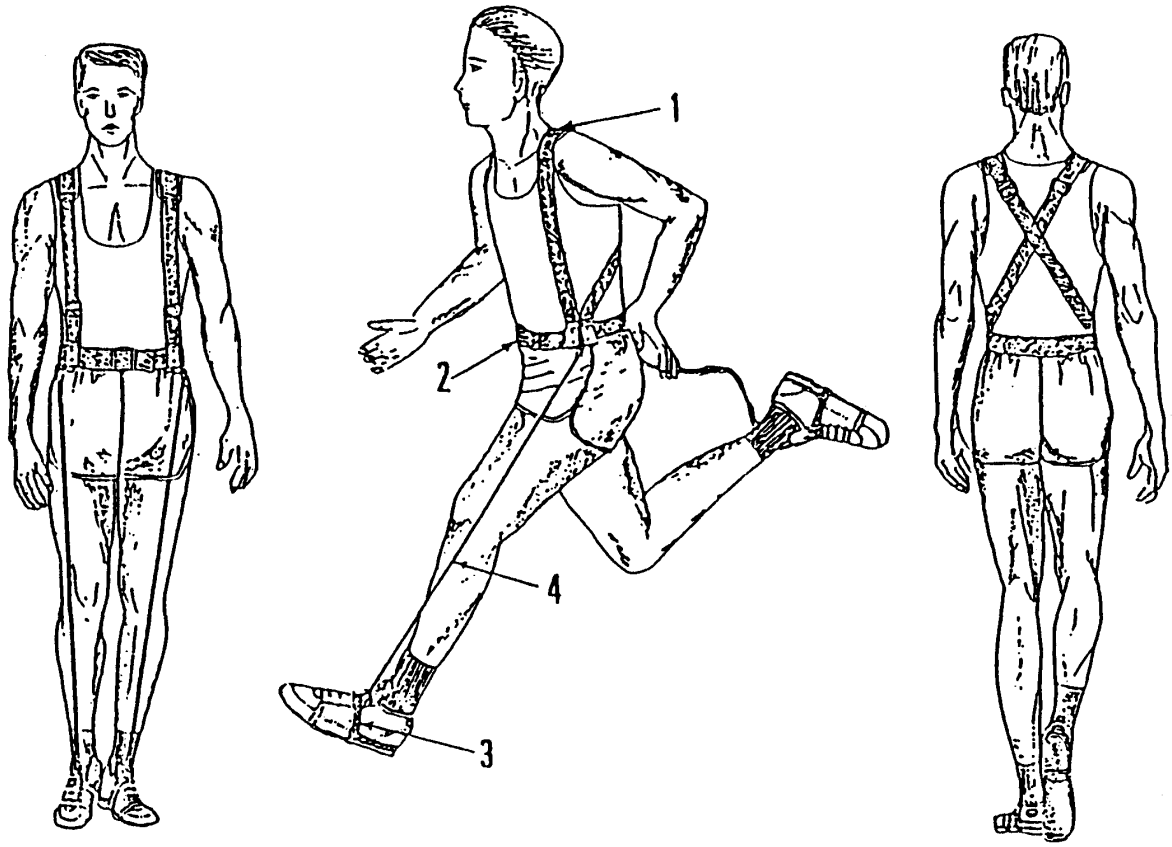

Fig. 1 Illustrative figure of the training equipment and its application.

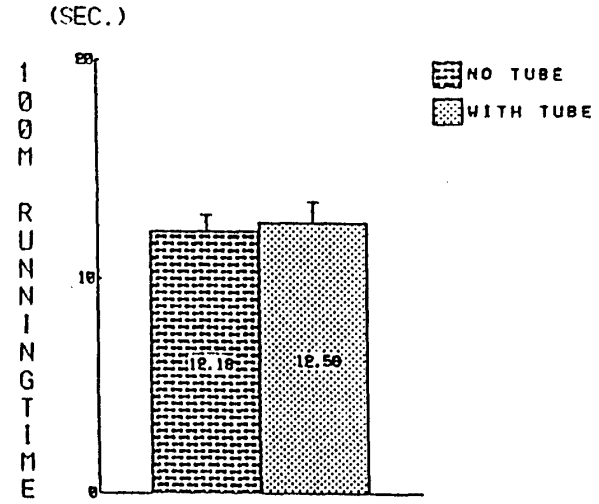

Fig. 2 Comparison of 100m running time for subject running with and without training tube.

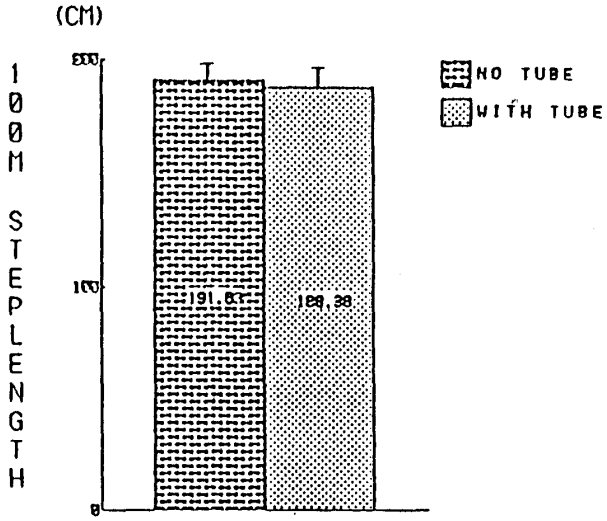

Fig. 3 Comparison of step length during the subject running with and without training tube.

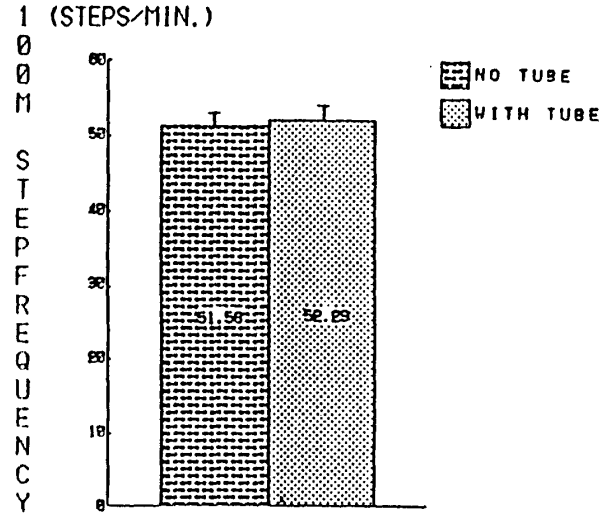

Fig. 4 Comparison of step freqeuncy for 100m dash when subject with and without using training tube.

TABLE 2 PERFPRMANCES OF 100M DASH

ITEMS / SUBJECT	100M-STEP FREQUENCY (NO TUBE)	100M-STEP FREQUENCY (WITH TUBE)	100M-STEP LENGTH (CM) (NO TUBE)	100M-STEP LENGTH (CM) (WITH TUBE)	RUNNINGTIME (SEC) (NO TUBE)	RUNNINGTIME (SEC) (WITH TUBE)
TAKAMORI	50	52	203.24	197.10	12.14	12.30
KOJIMA	51	53	190.95	185.09	12.32	12.40
TANAKA	49.5	53	182.42	180.63	11.89	12.26
OKUI	50.5	50.5	195.35	195.36	12.64	12.63
NISHIKAWA	54	54.5	178.54	176.42	11.46	11.68
MATSUURA	52.5	51	194.56	194.32	12.51	12.98
FUKASE	52.0	54.0	182.76	178.90	12.48	13.11
HASEGAWA	51.5	51.5	199.11	197.49	12.98	13.26
MOTEGI	49.5	48.5	193.06	193.46	10.94	11.52
NAKAGAWA	53.5	52.5	185.06	181.10	12.07	12.97
OHSHITA	50	51.5	194.90	188.76	12.29	13.42
TERAO	55	55.5	190.70	185.08	12.45	12.40
MEAN	51.583	52.291	191.63	188.38	12.180	12.578
SD	1.765	1.819	7.100	8.306	0.525	0.573

TABLE 3 PERFOMANCES OF 12 MINUTES RUN

ITEMS / SUBJECT	12 MINUTE RUN-DISTANCE (M) (NO TUBE)	12 MINUTE RUN-DISTANCE (M) (WITH TUBE)	12 MINUTE RUN-HEARTE RATE (/MIN) (NO TUBE)	12 MINUTE RUN-HEARTE RATE (/MIN) (WITH TUBE)
TAKAMORI	3120	2840	148	165
KOJIMA	3170	2880	168	171
TANAKA	3100	2500	168	159
OKUI	2980	2500	160	159
NISHIKAWA	3110	2820	124	150
MATSUURA	2980	2740	152	162
FUKASE	2940	2400	160	165
HASEGAWA	2760	2050	160	156
MOTEGI	3150	2730	164	165
NAKAGAWA	2960	2690	160	162
OHSHITA	2890	2600	120	156
TERAO	2750	2550	160	165
MEAN	2992.56	2608.33	153.667	161.25
SD	137.059	222.329	15.184	5.356

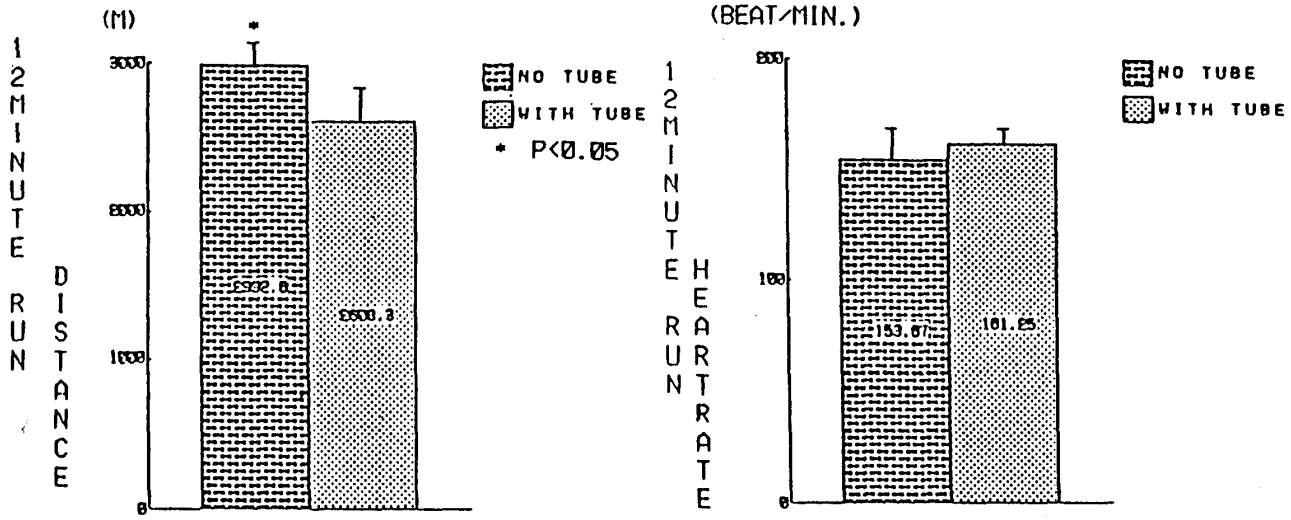

Fig. 5, 6 Comparison of 12'running distance (m), and heart rate after 12'run during with and without using training tube.

intensity, and saving time during walking or jogging.

EMGs from lower extremity: During errect posture when subject keeped in standing position without shaking or moving the centro-gravity of the body, amplitude of action potential in the muscle of lower leg increase its discharge while putting on the tube. Soleus as well as Gastrocnemius and Peroneus longus are thought to be the anti-gravity muscles which work against the gravity of body weight from upper trunk, the tube increase the load for these muscles (Fig.-7). The most characterized changes of EMGs during walking or running were increasing voltage of dischage of Rectus femoris during driving phase, and decraesing the voltage of dischange from Gilteus medius and biceps femoris anterior, and increase dischange of tibialis while start to move leg forward soon after the end of driving (Fig.-7). There is no notable patterns and amplitudes changes from Soleus, Gastrocnemius, and Peroneus longus during the phase of leg driving both with and without using the training tube.

Forms during running: from a series of pictures took with a high speed cinemacamera, it seems no prominent change of the running forms while with and without tube (photo-1, 2). The detail of the running forms now is under the computerized analysis which were not appeared in this paper, but from the time just before runner's foot landing the ground and at the end of driving the runner runs with a perfect form which could be seen with intuition. No discomfort that heard from the runners after they finished this exercise.

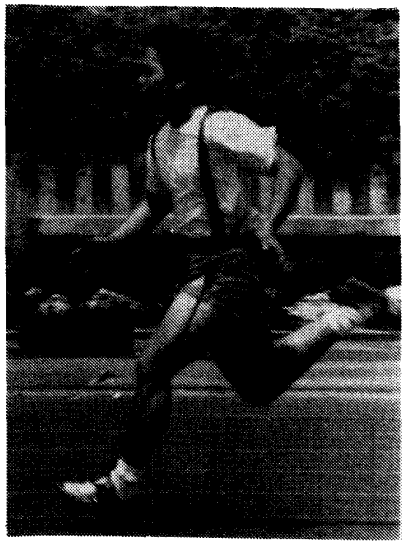

Photo. 1, 2 Photo 1 (right) shows the subject put-on training tube dash for 100m while the foot begin to touch the ground, photo 2 (left) shows the runner's foot just before to break the contact with the ground.

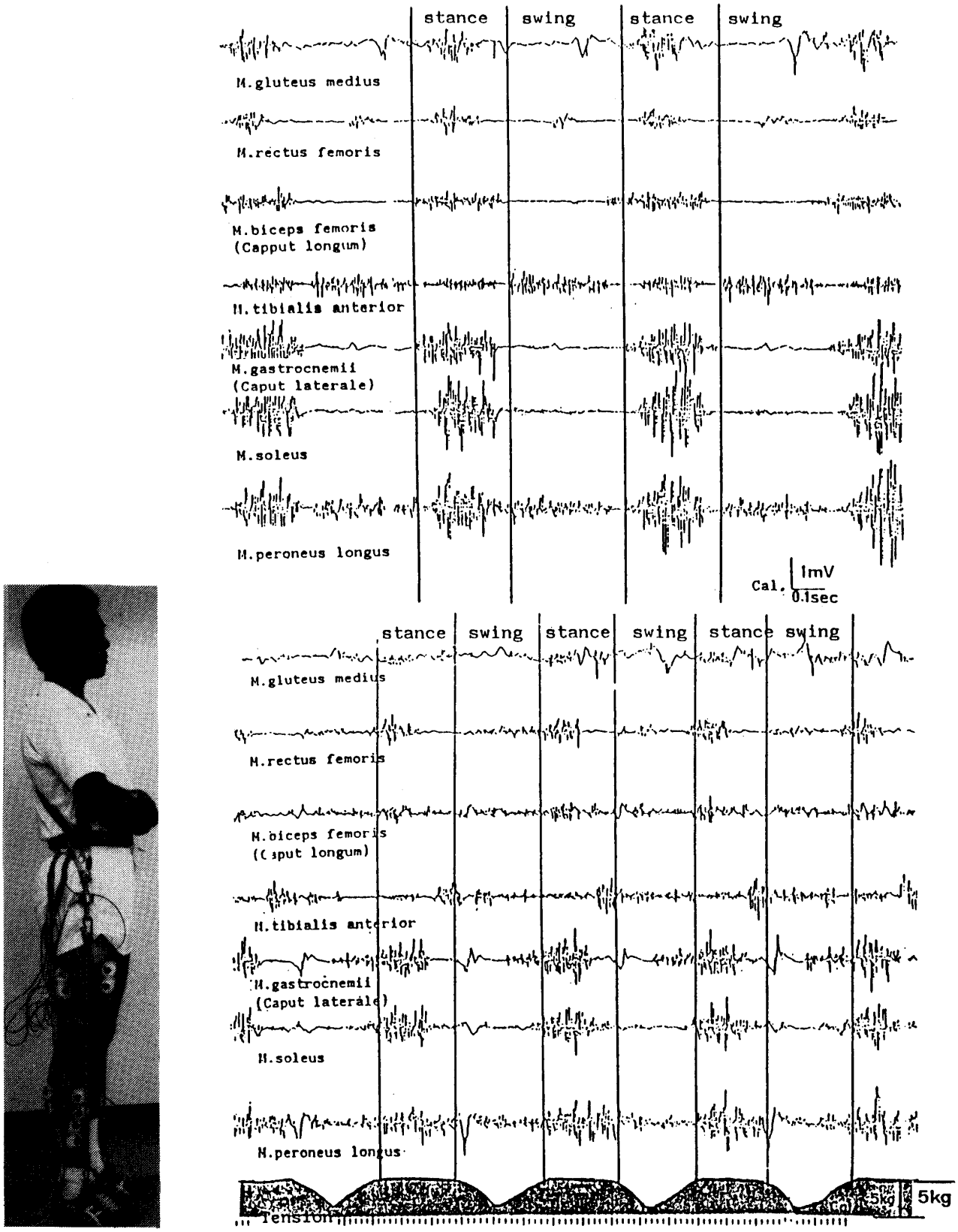

Fig. 7 EMGs of the muscles of lower extrimities during running, upper graph shows the subject running with fair speed without training tube, lower with training tube.

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